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WATER SUPPLY AND WATER QUALITY CONTROL STUDY, PACIFIC COASTAL STREAMS, SAN MATEO COUNTY, CALIFORNIA. A REPORT ON FUTURE WATER SUPPLY AND QUALITY CONTROL NEEDS AND BENEFITS

Federal Water Pollution Control Administration
San Francisco, California

August 1966

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WATER SUPPLY AND WATER QUALITY CONTROL STUDY

PACIFIC COASTAL STREAMS SAN MATEO COUNTY, CALIFORNIA

A REPORT ON FUTURE WATER SUPPLY AND QUALITY CONTROL NEEDS AND BENEFITS

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U.S. DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
SAN FRANCISCO, CALIFORNIA
AUGUST 1966

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WATER SUPPLY AND WATER QUALITY CONTROL STUDY

PACIFIC COASTAL STREAMS
San Mateo County, California

Abstract

This study indicates that supplemental municipal water supply needs in the San Mateo Coastal Area during the 1975-2075 evaluation period will increase from 7.4 to 43.7 million gallons per day. Total benefits from providing these needs have a present worth (1975) of $44,900,000 (equivalent to an annual value of $1,470,000 per year) including costs of conveyance works. No direct discharge of wastes to surface waters exists at present and local agencies have required that waste effluents be handled by ocean outfalls or land application rather than discharge to streams. It is anticipated that this practice will be continued so that there is no need for stream flow regulation for water quality control in the study area streams.

Prepared at the Request of

U.S. DEPARTMENT OF THE ARMY - Corps of Engineers, San Francisco District

by

U. S. DEPARTMENT OF THE INTERIOR

Federal Water Pollution Control Administration
San Francisco, California

August 1966

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INTRODUCTION

Request and Authority

Section 206 of the Flood Control Act of 1958 directed the District Engineer, San Francisco District to make a report on flood and related water resource problems in Pescadero Creek Basin, San Mateo County, California. Section 208 of the Flood Control Act of 1965 directed that a report be made concerning flood control and water resource development on all streams which drain to the Pacific Ocean from San Mateo County, California.

In a September 14, 1965 letter, the San Francisco District, U. S. Army Corps of Engineers requested that the Public Health Service evaluate the present and future need for and value of municipal and industrial water supply in the San Mateo County Coastal Area. In a November 4, 1965 letter the Public Health Service agreed to prepare a report evaluating water supply and quality control requirements in the San Mateo County Coastal Area. This study has been made in accordance with: (1) The Memorandum of Agreement dated November 4, 1958 between the Department of the Army and the Department of Health, Education, and Welfare relative to Title III of P.L. 500, 85th Congress, as amended by P. L. 87-88; and (2) the Federal Water Pollution Control Act, as amended (33 U.S.C. 466 et seq.)

Purpose and Scope

The purpose of this report is; (1) to estimate the present and future need for and value of municipal and industrial water supply; and (2) evaluate the need for and value of storage for water quality control. Both water supply and quality control aspects were evaluated for the entire service area which includes all of San Mateo County, California, that drains to the Pacific Ocean. The evaluation period is 100 years, from 1975 to 2075.

Acknowledgements

Valuable assistance and data for this study were provided by personnel of the following agencies:

U. S. Department of Army, Corps of Engineers
San Francisco District, San Francisco, California

California State Health Department
Bureau of Sanitary Engineering

California State Department of Water Resources (DWR)
San Francisco Bay District

San Francisco Bay Regional Water Quality Control Board

San Mateo County Flood Control District

San Mateo County Health Department

City of San Francisco Water Department

SUMMARY OF FINDINGS AND CONCLUSIONS

Findings

1. The 277 square mile service area includes all of San Mateo County that drains directly to the Pacific Ocean. There are three major sub-areas: North Coastal, which is suburban in character; Central Coastal, suburban-rural in character; and South Coastal, rural in character.

2. The North Coastal Area has no developable surface or ground water resources.

3. Median year runoff from the entire Central and South Coastal Area is estimated to be 126,000 acre feet. The area is broken up into small watersheds with 21 streams entering the ocean along approximately 41 miles of coastline. Only Pescadero - Butano (81 square miles) and San Gregorio (53 square miles) Creeks have drainage areas larger than 13 square miles. Most runoff (75-90%) occurs during the months of December through May but there is usually some flow year around.

4. The safe yield of ground water resources is not known but for the Central Coastal Area is greater than the 1,000 acre feet per year (AF/Y) presently pumped. The California State Department of Water Resources believes yields of individual wells are too low to be economically developed as a major water supply.

5. Flow-weighted surface water quality varies considerably between streams but except for the total dissolved solids concentration in San Gregorio Creek all are below the maximum chemical concentrations recommended in the Public Health Service Drinking Water Standards (1962). Dissolved oxygen concentrations approach saturation.

6. Ground water is more mineralized than the surface water but except in isolated cases it is satisfactory. The ground water table in the town of Pescadero is subject to contamination from overlying septic tank leaching fields or other surface sources.

7. The population of the study area was 34,635 in 1960 and approximately 53,500 in 1965. Much of the employed population commutes to jobs in San Francisco or "Bay-Side" San Mateo County. There is an extensive amount of agriculture, including several thousand acres of high value specialty crops such as artichokes, brussel sprouts and flowers. Recreational activity is significant at beaches, summer cabins, and organizational camps.

8. The North Coastal Area receives an average of 2.8 million gallons per day (mgd) treated water (its entire supply) from the San Francisco Water Department. The Half Moon Bay area is supplied 0.52 mgd from wells and by purchase of Pilarcitos Creek Water (this is a within basin source) from the San Francisco Water Department. The remainder of the study area is served by smaller systems or individual supplies from well or spring sources.

9. Approximately 8,000 AF/Y are applied to irrigated lands in the Central and South Coastal Areas. This water is from wells, private impoundments, and stream diversions.

10. The Regional Water Pollution Control Board has not allowed any waste discharges to surface streams in the study area and no water quality degradation exists. Most larger communities discharge wastes to the ocean through outfalls. Some smaller sewered communities discharge to land and several have no sewer system.

Conclusions

1. Corps of Engineers population projections indicate an increase from 53,500 in 1965 to 147,000 in 1995 and 279,000 in 2075. Agriculture is expected to remain an important part of the economy and the recreationally oriented sector to increase in importance. Most of the population will be economically oriented to the metropolitan area. Industrial development will be negligible.

2. Projected supplemental municipal and industrial (M&I) water needs in the service area are summarized as follows:

Sub-Area	Supplemental Water Use in Million Gallons Per Day		
	1975	1995	2075
North Coast*	5.2	9.7	16.6
Central Coast	2.0	7.8	15.4
South Coast	0.2	2.0	11.7
Total MGD	7.4	19.5	43.7
(Acre Feet/year)	8,300	21,900	48,900

*Needs Provided by San Francisco Department Until 1980

3. Agricultural water usage in the Central and South Coastal Areas is projected (by the DWR) to increase from 8,050 AF/Y in 1962 to 9,000 AF/Y in 1980 and then decrease to 6,510 AF/Y in 2020. Water released from agricultural use is a potential M&I supply.

4. Except for San Gregorio Creek water (which will probably be used after blending with other waters if at all) chemical quality of both surface and ground water is satisfactory for municipal and normal industrial use. However, the significant differences between the various sources are evaluated economically when comparing alternate plans.

5. All surface water supplies from coastal streams will require complete purification treatment while water delivered to the North Coastal Area from the San Francisco Water Department is assumed to be adequately treated. Differences in treatment cost are evaluated when comparing alternate plans.

6. The future role of the San Francisco Water Department in supplying water to the service area will greatly influence the logical plan of water development. However, at the present time they do not consider the Central and South Coastal Areas as part of their permanent service area. This evaluation assumes they will not supply any water to the Central Coastal Area after 1980 and may not supply supplemental needs of the North Coastal Area after 1980. Obviously, whenever definite plans of the Department become available they, should be considered in the water resource development plan.

7. Water supply from the San Francisco Water Department is considered to be the least cost, most likely alternate supply for the North Coastal Area. Water supply benefits from developing and conveying untreated coastal water to the Southern boundary of the area during the 1980-2075 period are:

Condition	Range of Supplemental Water Need 1980-2075 (10^3 AF/Y)	1975 Present Worth $\$10^6$	Annual Benefit
North Coastal Area			
Supply All Needs	7.1-18.6	15.7	$513,000
Supply All Needs Above 7100 AF/Y (1980 Rate)	0 -11.5	6.38	$209,000

8. Two alternate plans of staged water resource development were used to determine water supply benefits for the Central and South Coastal Area. Basic difference in the plans is that #1 assumes no San Francisco water is used in the Central Coastal Area after 1975 while #2 assume it will be used until 1980. Alternate #2 was found to be the least-cost alternate. Benefits are summarized on the following page.

Alternate	1975 Present Worth (10^6) Total	Conservation	Conveyance	Annual Benefit (10^6) Total	Cons.	Convey.
#2	29.2	19.7	9.5	.96	.65	.31
Pescadero	(29.2)	(19.5)	9.7	.96	.64	.32

Also shown are the benefits from building a project on Pescadero Creek initially. The total benefit is determined by the total for Alternate #2 but the conservation benefit differs because the conduit cost differ.

9. The water supply benefit from an initial development on Pescadero Creek providing a firm yield of 10,000 AF/Y is $11,600,000 or $380,000/year. The benefit is realized after water is diverted at the Pescadero division site and pumped to an elevation equivalent to the average pool in Bean Hollow Reservoir.

10. Local agencies are not in favor of waste treatment plant effluents discharge to any of the streams in the study area. Reasonable alternate means (primary treatment and ocean outfall or irrigation use) of waste disposal exist. Therefore, there is no need of stream flow regulation for water quality control and no water quality control benefits are applicable.

PROJECT DESCRIPTION

The Corps of Engineers is studying numerous streams in the service area to determine feasibility of providing flood control (both by storage and channel improvements), water conservation, and recreation enhancement. Multiple purpose reservoir sites on Pescadero, Butano, San Gregorio, Mills, Pilarcitos, and Denniston Creeks are being studied. In addition reservoirs on Arroyo de Los Frijoles and Gazos Creek are being evaluated as a least cost alternative for water conservation. The Corps may study even more streams in the future as plans for full development of the study area progress(1). See Figure 1 for a map of the study area.

Preliminary studies by the Corps indicate that the initial multiple-purpose reservoir should be constructed on Pescadero Creek at the Worley Flat site. Drainage area at the site is 37.5 square miles. The mean annual runoff at the site is about 25,000 acre feet and a net conservation yield of about 10,000 AF/Y is probably economically obtainable. Flood damages about the town of Pescadero approach $200,000 per year under present conditions of development and these could be almost completely eliminated by 30,000-35,000 acre feet of flood control storage. The site is located in a redwood forest, thus providing a scenic background for recreationists.

A reservoir larger than about 30,000 acre feet at the Worley site (2) would back up into Portola State Park, a prime redwood forest. The California State Department of Parks and Recreation in a 4 May 1964 letter to the California Department of Water Resources made the following statement: "The Department of Parks and Recreation is unalterably opposed to any development which would desecrate any of the esthetic or physical values for which the park was created. Therefore we recommend that consideration of the Worley Flat reservoir site be eliminated from consideration as a possible water storage project in the coastal San Mateo County Investigation."

Pescadero Creek is also the best steelhead trout and silver salmon stream on the San Mateo Coast. The California Department of Fish and Game has estimated an annual run of 1500 steelhead while the numbers of silver salmon are believed to be somewhat less. In a June 1964 report to the DWR the Department of Fish and Game recommended that detriments due to construction of a reservoir at Worley Flat be mitigated by: (1) construction of a hatchery below the dam; (2) proper fish ladders and screening of diversions at the downstream diversion structure; and releases of 4700 AF/Y (to the ocean).

The plan being considered by the Corps attempts to overcome these objections by: (1) limiting the non-flood control storage size to about 35,000 acre feet (31,500 water conservation and 3,500 minimum recreational pool); and (2) by releasing consumed water to the stream bed and diverting it near the town of Pescadero approximately six miles downstream thereby substantially increasing the dry season flow in this reach. The quantity of water that must remain in the stream below the diversion structure is still being negotiated.

Since the entire San Mateo County Coastal Area is included in the project service area it will be necessary to construct water conveyance facilities to transport water between water conservation reservoirs and service areas. Even though the Corps does not propose to build water conveyance facilities as part of their project it is necessary to cost these facilities to determine the cost of alternate water supply developments. Generally, the entire coastal strip from the San Mateo - San Cruz County line on the south to the San Mateo - San Francisco County line on the north will need water in the near future. Conduits covering the entire coastline would be needed unless it is found to be more economical to develop several local supplies to serve the widely scattered communities.

The California Department of Water Resources (DWR) investigated future water supply needs and possible water resource development in the Central and South Coastal Areas. Findings of this study are presented in Bulletin No. 138, "Coastal San Mateo County Investigation," March 1966. The extensive economic, hydrologic, and water use data presented in the DWR's investigation made it a valuable reference for this study.

STUDY AREA DESCRIPTION

Geography

San Mateo County is located immediately south of the City and County of San Francisco. The study area is the western portion of San Mateo County extending between San Francisco on the north and Santa Cruz County on the south. This is an area of 277 square miles containing 21 drainage basins and numerous streams.

The topography of the area consists of a narrow discontinuous strip of gently sloping marine terraces of moderate elevation, intersected by rolling hills which approximate the drainage divide of the major streams. East of the coastal benches the terrain rises rapidly in elevation to the drainage divide between streams which enter San Francisco Bay and the Pacific Ocean. These uplands are mostly wooded or brushy but there are some open grazing lands. The divide forms a portion of the Santa Cruz Mountains and varies in elevation from 1,000 - 2,500 feet.

Climate

The climate of the study area is typical of the Central California Coast. Frequent fogs occur during the summer and fall months causing moderate temperatures. Variations of less than 10°F in average daily temperatures occur between winter and summer months. Most precipitation occurs during the winter months from storms which move easterly from the Pacific Ocean. Mean annual precipitation varies from about 20 inches on the coast to over 50 inches at the higher elevations in the Santa Cruz Mountains.

Principal Communities

North Coastal Area contains 17.2 square miles. Most of this area is within the city limits of Pacifica, a suburban "bedroom" community oriented toward San Francisco. The Central Coastal Area contains 70.3 square miles is suburban - rural in character, and its major community is Half Moon Bay. The South Coastal Area (189 square miles) is rural in character. The only significant community is the town of Pescadero. Present industry consists primarily of agriculture and recreation.

WATER RESOURCES OF THE STUDY AREA

The North Coastal Area has no undeveloped water resources large enough to consider developing and is not discussed further in this Section. The possibility of importing water to this Section will be considered later.

Quantity of Surface Water Available

Most surface water runoff along the San Mateo coast occurs during short periods of time following periods of high rainfall. Many streams have a sustained base flow during periods of low rainfall. The DWR has developed estimates of long-term runoff at the Pescadero Creek gaging station (see Table 1) from short-term records on three streams, precipitation data, and correlation with nearby gaging stations outside the study area. The gaging stations in the study area and their date of initial operation are: Pescadero Creek near Pescadero (1951); Purisima Creek near Half Moon Bay (1959); and Butano Creek near Pescadero (1962).

The DWR computed a mean annual precipitation value of 32 inches for an area essentially equivalent to the Central and South Coastal Areas and 37 inches for the Pescadero Creek Basin portion of this area. With an average annual runoff of 31,100 acre feet at the Pescadero gage the estimated average runoff for the 166,000 acre Central and South Coastal area is 152,000 acre feet. The median year runoff at the Pescadero gage is about 25,700 acre feet and for the Central and South Coastal Area is computed as 126,000 acre feet. These total runoff figures give an indication of the amount of water theoretically available but much of the runoff is from very small drainage areas and it is unlikely that even one-half of this total can be economically developed.

The extent that this area is broken into small watersheds must be kept in mind when considering the problems of economically developing water supplies. Twenty one streams enter the ocean along approximately 41 miles of coastline. Pescadero (including Butano) Creek with a drainage area of 81 square miles and San Gregorio Creek with a drainage area of 53 square miles are the only ones with drainage areas larger than about 13 square miles. The DWR, in their investigation of the San Mateo Coast, considered 24 damsites on 12 other streams and only three of these (Purisima, Tunitas, and Gazos Creeks) had drainage areas larger than 8 square miles.

Several streams have significant quantities of uncontrolled runoff that could be diverted during 5-8 months of the year but flows of one cubic foot per second (cfs) or less are common for 4-7 months of the year.

TABLE 1

HISTORICAL RUNOFF AT THE PESCADERO CREEK
STREAM GAGING STATION
(acre-feet)

Water year	Runoff	Water year	Runoff	Water year	Runoff
1899-1900	19,400	1921-22	32,300	1943-44	12,200
01	66,000	23	28,500	45	26,700
02	40,100	24	1,000	46	17,700
03	30,000	25	24,800	47	6,400
04	49,300	26	42,500	48	7,100
05	32,500	27	44,000	49	16,700
06	47,500	28	20,700	1949-50	14,700
07	58,700	29	7,400	51	43,700
08	11,200	1929-30	21,300	52	66,920
09	65,000	31	3,000	53	31,900
1909-10	14,800	32	33,000	54	16,520
11	81,000	33	7,000	55	15,660
12	9,500	34	18,200	56	66,970
13	3,300	35	29,800	57	13,090
14	81,600	36	11,300	58	74,790
15	43,500	37	27,200	59	11,980
16	49,000	38	63,500	1959-60	7,410
17	24,300	39	4,800	61	4,000
18	10,000	1939-40	59,400	62	16,800
19	23,200	41	94,200	63	47,990
1919-20	8,300	42	53,700	64	7,490
21	36,100	43	38,800		

Source: California Department of Water Resources, Bulletin No. 138.

Table 2 shows the average monthly distribution of the average annual runoff at the Pescadero and Purisima Creek gages. Note that Purisima Creek, which is spring-fed, has 20.3% of annual runoff during the 5 month period June-October compared to 6.2% for Pescadero Creek. Two years record on Butano Creek indicate that 10-15% of flow may occur in this period.

There is a significant amount of water used for irrigation in the service area (DWR estimates 8,050 acre feet were applied in 1962). This water comes from private impoundments, direct diversions by users with riparian or appropriative rights, and from ground water.

There are over 140 reservoirs in the coastal area with an estimated firm annual yield of about 2500 acre feet. Listed in Table 3 are 8 of these reservoirs which are formed by dams large enough to require licensing under provisions of the California Water Code. The remaining reservoirs probably have little effect on dry weather stream flow but could significantly reduce yields of future downstream reservoirs, especially those with small drainage areas.

Most of the irrigated water used is probably obtained from stream diversion. Appropriative rights on three of the streams (Gazos, Pescadero, and Butano) exceed typical dry weather flows. The extent that these rights are utilized and the magnitude of diversions by riparian users is not known. Until more detailed studies indicate otherwise, it should be assumed there is no surface water available for diversion after June 1.

Pilarcitos Reservoir on Pilarcitos Creek, owned and operated by San Francisco Water Department is the only reservoir in the service area providing signficant regulation. It has a capacity of 3100 acre feet and a drainage area of 3.8 square miles. Most of the runoff at this site is diverted by tunnel into San Francisco's Crystal Springs Reservoirs located on the San Francisco Bay side of San Mateo County. However, small amounts of supplemental water (155 acre feet in 1962-63 and 255 acre feet in 1963-64) are sold to the Coastside County Water District which serves the Half Moon Bay area.

Quantity of Ground Water Available

Ground water in the coastal area is derived from precipitation which penetrates the marine terraces and alluvial valleys and from surface runoff which penetrates aquifers immediately adjacent to the stream channels or which drains from adjacent hillsides onto the terraces and valleys. Development of ground water as an important water supply source is primarily confined to wells in the marine terrace around Half Moon Bay and aquifers adjacent to stream channels north of Half Moon Bay. Ground water development south of the City of Half Moon Bay is limited to small domestic irrigation wells of minor importance.

TABLE 2

AVERAGE MONTHLY DISTRIBUTION OF THE AVERAGE ANNUAL RUNOFF AT THE PESCADERO AND PURISIMA CREEK STREAM GAGING STATIONS DURING THE PERIODS OF RECORD*

Month	Percent of Annual Runoff	
	Pescadero Creek	Purisima Creek
October	1.2	7.7
November	2.7	4.2
December	13.0	5.4
January	19.5	11.8
February	25.0	23.5
March	18.4	13.9
April	9.6	13.6
May	5.6	7.3
June	2.2	4.4
July	1.3	3.1
August	0.9	2.4
September	0.6	2.7
Average Annual Runoff	100.0	100.0

*Periods of record are 1951-52 to 1963-64 for Pescadero Creek and 1958-59 to 1963-64 for Purisima Creek.

TABLE 3

IRRIGATION DAMS IN THE COASTAL AREA OF SAN MATEO COUNTY
UNDER SUPERVISION OF THE CALIFORNIA
STATE DEPARTMENT OF WATER RESOURCES

Dam	Watershed	Capacity (acre-feet)	Drainage area (sq.miles)	Estimated firm yield (acre-feet/yr)
Johnston	Arroyo de Leon	30	7.6	30
Pomponio Ranch	Pomponio Creek	256	0.6	150
Lake Lucerne	Arroyo de Los Frijoles	455	4.7	1,250
Bean Hollow No. 2	Arroyo De Los Frijoles	900	1.4	a
Bean Hollow No. 3	Arroyo De Los Frijoles	461	1.2	a
Green Oaks No. 1	Green Oaks Creek	287	1.0	190
Lake Elizabeth	Green Oaks Creek	113	0.83	100
Coastways	Ano Nuevo Creek	100	0.12	90

a. Included in yield of Lake Lucerne.

A total of about 450-500 AF/Y of ground water is used for urban and domestic purpose in the Central Coastal Area. This includes water pumped from individual wells as well as that provided by the water systems. It is estimated that in 1962 about 600 acre feet of ground water was used for irrigation in the Half Moon Bay - Montara - Moss Beach Area. No data is available on quantities of ground water pumped from aquifers south of Half Moon Bay.

No estimates of ground water storage or safe yield have been made in the study area. The DWR considered the possibility of meeting part of the future supplemental water requirements by ground water development. The yield factor was found to be low, with the average production being about 35 gallons per minute. They concluded that the yields of wells were too low to allow economical development.

Other Sources of Supply

The North Coastal Area purchases its entire water supply from San Francisco Water Department. The quantity of water purchased was 1870 acre feet in the 1962-63 water year and increased to 2560 acre feet in 1963-64 water year (3). The present water contract expires in 1980 and obligates San Francisco to provide the 1980 rate of usage perpetually. However, San Francisco has indicated they consider the North Coastal Area as part of their permanent service area.

The City of San Francisco's water supply system is a possible source of future supplemental water for the San Mateo Coastal Area. This water is derived from Tuolumne River, Alameda County, and San Mateo County sources. Upper and Lower Crystal Springs Reservoirs, located only a mile east of the study area drainage divide are important storage facilities for the San Francisco system. The present (about 220 mgd) and future (development up to 525 mgd in 1985 has been considered) capacity of this system is large compared to the needs of the coastal area (4). However, their permanent service area includes portions of southern Alameda and northern Santa Clara Counties, all of "Bay-Side" San Mateo County, and the North Coastal Area of San Mateo County as well as the City of San Francisco. Due to uncertainties in future water needs of this extensive and heavily populated service area, the City of San Francisco has been reluctant to further extend their service boundaries to include the Central and South Coastal Areas and therefore cannot be counted as a source of supply. However, it is possible that San Francisco's situation will change by 1980 when most of their major water contracts expire.

Quality of Water Available

Chemical analyses have been made by the DWR on waters from Pescadero, Butano, San Gregorio, Whitehouse, Purisima, Gazos, and Denniston Creeks. These samples were taken monthly or semi-monthly during the period from September 1963 through May 1964. These are

sufficient data to draw preliminary conclusions about the variation of quality with streamflow. This was a year of less than average runoff (1 in 6 year low flow frequency) and it is likely that chemical concentrations were higher than would be found in years of average or median runoff. Samples taken in January and June 1953 (a year of about average runoff) on most of these creeks indicate that quality is probably better in average years. However, evaluation of these data will allow comparison between the various creeks and indicate probable quality during future drought years.

Average (flow-weighted) water quality is shown in Table 4. In general, these averages are less than the maximum chemical concentrations recommended in the Public Health Service Drinking Water Standards (1962). An exception is San Gregorio Creek where the average total dissolved solids concentration of 565 milligrams per liter (mg/l) exceeds the recommended limit of 500 mg/l. On Butano Creek, one of two iron analyses in 1953 was 0.4 mg/l exceeding the recommended limit of 0.3 mg/l while on Whitehouse Creek the only analyses indicated an iron concentration of 0.94 mg/l. There were no determinations made of iron concentrations in these two streams during the 1963-64 analyses.

In all cases dissolved oxygen concentrations approached or slightly exceeded saturation levels. ABS detergent was not detectable in any sample. These findings indicate no measurable pollution present in the streams.

There is a wide variation in average hardness concentrations in the different streams. There are significant economic detriments incurred when waters of higher hardness concentration are used in municipal water supply systems. These detriments are due to increased use of soap, scale formation in hot water heaters, dishwashers, pipes, and cooking utensils. These detriments are measurable and will be considered when evaluating alternate development schemes.

Ground water chemical quality of the Coastside County Water District wells has similar characteristics to overlying Pilarcitos Creek water (although concentrations are 20-60% greater) and satisfactory for municipal and most industrial uses. Citizens Utilities Company wells in the Montara - Moss Beach Area have water quality similar to the Pilarcitos Creek wells (see Table 5)(5). The DWR has reported poor ground water quality in the Half Moon Bay Terrace and San Gregorio Creek Basins and speculated that it may be due to sea water intrusion.

The community of Pescadero is supplied by private wells that draw from a water table normally at 25-30 feet depth. This soil is relatively pervious and the water table is not protected by an impervious strata. In a recent drought year the nitrate concentrations in the ground water increased alarmingly (up to 20-30 mg/l) and was of concern

TABLE 4

SURFACE WATER QUALITY
SAN MATEO COUNTY COASTAL STREAMS
(September 1963 - May 1964)
1/
CHEMICAL CONSTITUENTS

Creek	Total Dissolved Solids		Total Hardness		Temp. Range (°F)	Dissolved Oxygen (% Saturation)	Turbidity
	Range	Flow-Weighted Average	Range	Flow-Weighted Average			
Denniston	131-170	153	72-90	79	46-70	89-109	3.25-8.0
Purisima	372-445	404	267-310	292	45-62	92-103	1.5 -3.2
San Gregorio	465-636	565**	253-360	325	42-71	94-108	1.5 -60
Pescadero	310-476	376	177-266	214	38-66	93-112	2.7 -55
Butano	185-272	225	99-160	131	41-61	77-97	33 -330*
Gazos	179-223	206	97-111	102	39-58	89-102	3.6 -32
Whitehouse	233-357	298	101-176	129	41-58	81-98	20 -70*

1/ Expressed in milligrams per liter unless otherwise noted.
Also analyzed for specific conductance, pH, calcium, magnesium, sodium, potassium, carbonate, bicarbonate, sulfate, chloride, nitrate, fluoride, boron, silica, iron, aluminum, arsenic, copper, lead, manganese, zinc, hexavalent chromium, and A.B.S. All concentrations meet Public Health Service Drinking Water Standards unles noted below.

* One iron sample taken in 1953 indicated concentrations slightly above maximum recommended (0.3 mg/l) in PHS Drinking Water Standards (1962).

** PHS Standard is 500 mg/l. (Water containing concentrations that exceed the recommended limits should not be used if alternate supplies are available.)

TABLE 5

GROUND WATER QUALITY[1/]
SAN MATEO COUNTY COASTAL AREA

Well Location	Total Dissolved Solids (mg/l)	Total Hardness (mg/l)	Comments
Montara Point (Citizens Utility Co.)	187-320	92-152	2 Samples (1952 and 1953)
Pilarcitos Creek (Coastside CWD)	256-348	163-185	Several Samples (1956)
Half Moon Bay Terrace Irrigation Wells[2/]	318-597	118-320	1 Sample Each From 5 Scattered Wells (1953)
[3/]	1740	921	
San Gregorio Creek Basin[4/]	1690	641	Sample From 1 Well (1953)

1/ Also analyzed for calcium, magnesium, sulfate, nitrate nitrogen, chloride, fluoride and iron. Some samples analyzed for sodium, potassium, carbonate, bicarbonate, Boron, Silica and alkalinity. Water meets Public Health Service Drinking Water Standards unless otherwise noted.

2/ Two of 5 wells sampled exceeded the maximum total dissolved solids concentrations recommended by the PHS, One well exceeded recommended iron concentration.

3/ Exceeds PHS standard for total dissolved solids, chloride, and sulfate.

4/ Exceeds PHS standards for total dissolved solids and chlorides.

to the County Health Department (6). This was believed to be caused by percolating waters from septic tank leach fields in the non-sewered community. Under normal conditions, this ground water aquifer is supplied by subsurface flow from higher ground and quality has not been a problem.

THE ECONOMY

Present

The estimated population of the entire study area has grown from 34,635 in 1960 to 53,500 in 1965. (See Table 6 for the sub area breakdown)(7). The area is in proximity to heavily populated portions of the San Francisco Bay Area. Downtown San Francisco (1960 population of about 740,000) is only 11 airline miles from the center of Pacifica. Most of the San Mateo County "Bay-Side" population (approximately 410,000 in 1960) is within 3-15 airline miles of the coast. The center of San Jose (1960 population of 602,800 in the metropolitan area) is less than 30 airline miles from the coast. Most employed persons in the North Coastal Area and a significant portion of those in the Central Coastal Area commute to jobs in San Francisco or San Mateo County.

The Corps of Engineers estimates that 104,050 acres were devoted to agriculture in 1965 including hillside grazing lands. For the Central and South Coastal areas the DWR reports 5,439 acres of irrigated land and 14,186 acres of non-irrigated field corps in 1962. Most irrigated acreage is along the coast and consists of high value speciality crops such as brussel sprouts (1962 acres), miscellaneous vegetables (1071 acres), artichokes (762 acres), flowers (658 acres), and strawberries (78 acres). There are also 875 acres of irrigated pasture, and 33 acres of miscellaneous crops. The cool, moist coastal climate is conducive to growth of these crops and yields per acre are high enough so that it is economical to farm small acreages. For instance the return to land and water per acre is estimated as $585 for flowers, $595 for strawberries, and $195 for brussel sprouts.

Except for the presence of the commercial establishment necessary to service the local population, recreation is the only other significant local industry. Summer cabin occupants and day-visitors participate in sunbathing and rock fishing along the coast. In the redwood areas of Pescadero and San Gregorio Creeks there are numerous summer residences and organization camps. There are overnight and day use activities at Memorial and McDonald Parks, both owned and operated by San Mateo County. The State Division of Beaches and Parks operates Portola and Butano State Parks and the San Mateo Beaches State Park which consists of numerous parcels of ocean frontage. Estimated 1960 recreational usage for the entire coastal area was 1,340,000 visitor-days. The breakdown by type of activity is shown in Table 7.

Future

Population projections developed by the Corps of Engineers for the 1965-2075 period are shown in Table 6. Inspection of this table indicates that all areas will undergo rapid growth between 1965 and 1975 and that growth will continue at different rates until 2075. Between 1975 and 1995 the Central Coastal Area is projected to grow at an annual rate of 4.8% and

TABLE 6

POPULATION PROJECTIONS, 1960 - 2075[1/]

SAN MATEO COUNTY COASTAL AREA

Sub-Areas	1960[2/]	1965	1975	1995	2015	2035	2055	2075
North Coastal	27,000	42,000	60,000	80,000	96,000	110,000	120,000	126,000
Central Coastal	5,296	8,500	21,000	54,000	70,000	76,000	82,000	85,000
South Coastal	2,339	3,000	5,000	13,000	28,000	46,000	61,000	68,000
San Gregorio Creek Basin	(1,067)	(1,425)	(2,400)	(5,800)	(9,000)	(13,500)	(16,000)	(16,500)
Pescadero Creek Basin	(816)	(950)	(1,600)	(3,000)	(4,500)	(8,000)	(14,500)	(19,500)
Remainder	(456)	(625)	(1,000)	(4,200)	(14,500)	(24,500)	(30,500)	(32,000)
TOTAL	34,635	53,500	86,000	147,000	194,000	232,000	263,000	279,000

1/ From Economic Base Study, San Mateo Coastal Area, Pacific Coastal Streams, U. S. Army Corps of Engineers, February 1966.

2/ Estimate based on 1960 Census of Population and data supplied by the San Mateo County Planning Commission.

increase by 33,000 people. From 1995-2075 the growth rate is fastest in the South Coastal Area, averaging 2.1% annually.

Agriculture is expected to retain an important position in the areas economy throughout the study period. Overall agricultural land use is projected to drop from 104,050 acres in 1965 to 46,550 in 2075 and to disappear entirely from the North Coastal Area by 2040. It is expected that the remaining agricultural land will be more intensely used than at present.

Recreational activity is expected to grow rapidly during the study period. Total visitor days projected for 1975 is 4,000,000 and for 2075 it is 44,000,000 (see Table 7). The Pescadero Creek Basin is expected to receive about 25% of the total visitor days and 67% of the camping days while the San Gregorio Creek Basin is expected to receive only 1% of the total recreation.

The most important factor in population growth will be the expanding industrial and commercial development in San Francisco, "Bay-Side" San Mateo, and Santa Clara Counties. Coastal San Mateo County will become more and more of a "bedroom area" that is economically dependent on outside areas. For this reason most of the population growth is expected to occur in the areas most accessible to the outside population center. Commercial activity is expected to increase with increasing population. Industrial development is expected to be modest and to include no heavy water users.

TABLE 7

PROJECTED RECREATION USE, 1960 - 2075 [1/]
SAN MATEO COUNTY COASTAL AREA

(Visitor-Days)

Year	Total Visitor Days (Rounded)	Type of Use						
		Swimming	Fishing	Camping	Boating	Picnicking	Riding and Hiking	Hunting [2/]
1960	1,300,000	450,000	230,000	50,000	10,000	500,000	50,000	50,000
1975	4,000,000	1,350,000	325,000	220,000	35,000	1,500,000	390,000	140,000
1995	10,800,000	3,300,000	640,000	780,000	105,000	3,750,000	2,100,000	95,000
2015	20,000,000	6,100,000	890,000	1,620,000	190,000	7,100,000	4,100,000	57,000
2035	30,800,000	9,300,000	1,050,000	2,500,000	260,000	11,300,000	6,400,000	43,000
2055	38,300,000	11,500,000	1,140,000	3,100,000	310,000	14,200,000	8,000,000	40,000
2075	44,000,000	13,000,000	1,170,000	3,600,000	350,000	16,900,000	8,900,000	40,000

1/ From Economic Base Study, San Mateo Coastal Area, Pacific Coastal Streams, U. S. Army Corps of Engineers, February 1966.

2/ Due to urban development and extended recreation use of the area, it is assumed that San Mateo County authorities will discourage hunting.

WATER REQUIREMENTS - MUNICIPAL AND INDUSTRIAL

Past and Present Water Use

North Coastal Area. Essentially all water used in this area is provided by the North Coast County Water District which purchases its entire supply from the San Francisco Water Department. The water is treated (chlorination and fluoridation) by San Francisco. In 1965, the population served was 32,000 and water use was 3130 acre feet (2.8 mgd). Annual water use is increasing rapidly in this area due to population increase (about 10,000 persons between 1960 and 1965) and a gradual increase in use from about 75 gallons per capita day (gpcd) in 1959-60 to 87 gpcd in 1965.

Central Coastal Area. There are two "large" municipal water systems in this area (State Health Department regulations define any water system with over 200 service connections as large). The Citizen Utilities Company serves about 2000 persons in the Montara - Moss Beach Area from 4 wells and a spring on Montara Creek. All water is chlorinated and the spring water is also settled. Water supplied in 1961 (latest data available) was about 100 acre feet or 64 gpcd for a population of 1400. The production capacity of the system is limited and is at least partially responsible for the low per capita consumption.

In 1965 the Coastside County Water District served about 6400 persons in the Half Moon Bay - El Granada Area from 4 wells located in Pilarcitos Creek and by purchase of Pilarcitos Reservoir water from San Francisco. The only treatment provided is chlorination. Total water delivered in 1965 was 585 acre feet (0.52 mgd) or 82 gpcd. In a typical year, the District will produce 150-200 acre feet from its wells and purchase supplemental needs from San Francisco. Water use has increased from 390 acre feet in 1960 while per capita consumption has fluctuated from about 78-110 gpcd.

The only other known community water system in the Central Coastal Area is that of the Princeton Utility District. This system supplies untreated well water to approximately 250 persons residing in Princeton. A large number of persons reside outside the service area of water systems and are supplied from their private wells. The DWR has estimated that about 0.18 mgd (200 acre feet) per year of water is pumped from these wells.

It is estimated that about 3660 acre feet was applied to about 2400 acres of land in the Central Coastal Area. It was necessary to estimate this quantity of water from an applied agricultural water field measurement program since there are little data on agricultural water utilization. Over 600 acre feet of this total was estimated to be from ground water. Surface water is obtained from small reservoirs (Johnston Dam is the only one of the larger reservoirs shown in Table 3 that is in the Central Coastal Area) and from direct stream diversions - often

by pumping from flashboard dams. There are numerous appropriative rights to impound or divert small quantities of water and undoubtedly there is extensive riparian use.

South Coastal Area. The only "large" municipal system in this area is that of the Cuesta - La Honda Mutual Water Company which supplies chlorinated creek and spring water to about 910 persons in the La Honda area. Two smaller systems (La Honda - San Gregorio and La Honda - McDonald) serve an additional 400 persons in the San Gregorio Creek Basin. In the Pescadero - Butano drainage, the Loma Mar and Butano Canyon Mutual Water Companies serve about 220 persons. All other persons in this area (including the town of Pescadero) are supplied by individual ground or surface water supplies.

Agricultural water use in the South Coastal area for 1962 was estimated as 4390 acre feet (540 in San Gregorio Basin, 270 in Pomponio Basin, 2,510 in Pescadero-Butano-Gazos Basins, and 1070 in Ano Nueva area). Most of this supply is from surface water. There is 1780 acre feet of firm yield in the South Coastal Reservoirs shown in Table 3, the most significant developments being 1250 acre feet in Arroyo de Los Frijoles Creek and 290 acre feet on Green Oaks Creek. There are 3.2 cfs appropriative diversion rights from Gazos Creek, 3.4 cfs from Pescadero Creek, and 2.0 cfs from Butano Creek. There are appropriative rights to store or divert lesser quantities of water on several other streams and tributaries in the area. Little is known of the quantity of ground water used for agriculture in this area but it is believed to be minor compared to surface sources.

All chemical analyses taken of present water developments indicate satisfactory quality. There is little opportunity for significant reuse of water due to the geography of the area so it is unlikely that a long term buildup of mineral concentrations will occur. Problems of biological and bacteriological contamination could occur either from septic tank leaching, such as at Pescadero, or from man-caused contamination of surface waters. These problems can be controlled by adequate waste discharge and municipal water treatment requirements.

Future Water Use

Municipal and industrial (M&I) water supply needs were projected for the 1975-2075 period. Population and land use projections by duo decade were obtained from the Corps of Engineers "Economic Base Study, San Mateo County Coastal Streams, February 1966."

Projections were made for the three major areas with the South Coastal Area being further broken down into Pescadero Creek Basin, San Gregorio Creek Basin, and Remainder.

Water use was broken into five categories: (1) residential - inside in gallons per capita day; (2) commercial and residential - outside in gallons per acre-day; (3) industrial in gallons per acre-day; (4) non-camping recreation in gallons per visitor-day; and (5) camping recreation in gallons per camping-day. The coefficients used for this projection are shown in Table 8.

This breakdown gives a more rational basis for water use projection than simply assigning a gallons per capita day figure to an entire area because it is possible to reflect a changing "mix" of the various aspects of the economy that influence water use. For instance, in 1995 the Central Coastal Area is projected to have 37% of the population and 86% of the industry whereas the Pescadero Creek Basin would have 2% of the population and 21% of the recreation use. Also, it gives a better indication of the extent that water consumption can be reduced in times of water shortage.

These water use figures are high compared to current consumption in the service area, but are typical of other more urbanized coastal areas with similar climate and good water systems. Limited water system capacity holds down current per capita consumption. Also probably many persons served by the water systems have wells to use for outside watering. With provision of a good distribution system water use will tend to increase and use of wells will undoubtedly diminish. Recreation water use is typically from local wells, springs, or creeks but in the future as recreation demand becomes heavier it will be necessary to integrate some of the recreation area water supplies with the main system. All of these factors are reflected in the use coefficients which shows per capita increases between 1975 and 2015.

Projected supplemental M&I water needs are shown in Table 9. It is evident, if these needs develop as projected, that major water supply imports or local developments will be needed by 1975 or 1980 to supply the North and Central Coastal Areas. Water needs in the South Coastal Area develop at a somewhat slower rate and are likely to occur in several widely scattered locations. The need for major water developments to serve this area is not urgent since in the absence of an area wide water supply project the projected needs could be supplied by local stream developments until some time after 1990. Alternate plans for providing water service for the entire coastal area are discussed in more detail in the section on benefits.

The DWR projected agricultural water requirements for various subareas of the Central and South Coastal Areas by decade from 1970 to 2020. These data are summarized in Table 10. The total applied water uses from 8050 AF/Y in 1962 to 9000 in 1980 then decreases to 6510 in 2020. In the Central Coastal Area use is expected to continually decrease from the present time to zero by 2020 while in the South Coastal Area total use increases until 1990 and then declines.

TABLE 8

WATER USE COEFFICIENTS

FOR

SAN MATEO COUNTY COASTAL AREA

Type of Use	Units	1975	1995	2015-2075
Residential-Inside	Gallons/capita-day	60	80	100
Commercial and Residential-Outside	Gallons/acre-day	270	450	450
Industrial	Gallons/acre-day	2000	2000	2000
Recreation-Non Camping	Gallons/visitor-day	3	7	10
Recreation-Camping	Gallons/camping-day	10	20	30

TABLE 9

1/
SUPPLEMENTAL MUNICIPAL AND INDUSTRIAL

WATER NEEDS

SAN MATEO COUNTY COASTAL AREA

(Acre Feet Per Year)

Sub-Area	Year					
	1975	1995	2015	2035	2055	2075
Central Coast	2,220	8,760	13,000	14,600	16,200	17,200
South Coast	230	2,200	5,920	9,530	11,900	13,100
(Pescadero)	(90)	(510)	(1,110)	(2,040)	(3,100)	(3,790)
(San Gregorio)2/	(80)	(760)	(1,630)	(2,390)	(2,750)	(2,890)
(Remainder)2/	(55)	(930)	(3,180)	(5,100)	(6,080)	(6,430)
Sub-Total	2,450	11,000	18,900	24,100	28,100	30,300
North Coast	5,850	10,900	15,000	16,700	17,900	18,600
Total	8,300	21,900	33,900	40,800	46,000	48,900

1/ These are supplemental water needs. Existing urban water development (Based on DWR Bulletin #138, Tables 22 and 23) in acre feet per year is assumed to be 900 for Central Coast, 100 for Pescadero Basin, and 200 for San Gregorio Basin.

2/ It has been assumed that 2/3 of South Coast - Remainder water use will be north of Pescadero Creek and the remaining 1/3 South of Pescadero Creek. It has also been assumed that ½ of San Gregorio water use will be in La Honda area and the remaining ½ in Coastal portion of basin.

TABLE 10

PRESENT AND PROJECTED APPLIED
AGRICULTURAL WATER REQUIREMENTS
IN THE
CENTRAL AND SOUTH COASTAL AREA OF SAN MATEO COUNTY

AREA	YEAR			
	1962	1980	1990	2020
Central Coast	3660	1700	1060	0
South Coast	4390	7300	7390	6510
San Gregorio	(540)	(740)	(750)	(490)
Pescadero	(2510)	(4200)	(4270)	(3850)
Remainder	(1340)	(2360)	(2370)	(2170)
TOTAL	8050	9000	8450	6510

Projections from Department of Water Resources Bulletin No. 138.

This decline in agriculture water use frees developed water for possible urban use and should not be overlooked in a detailed water resource planning study. The amounts of surplus agricultural water are significant in the Central Coastal Area prior to 1980 and in the South Coastal Area after 1990. These sources will be scattered and costs would arise in collecting, treating, and integrating them with a central system but significant economies could still result. Other uses such as lawn and park watering or use by commercial or industrial firms would not require integration into a central system but would reduce the demand upon it.

Municipal, Industrial, and Agricultural Pollution

There are no municipal or industrial waste discharges to surface streams in the service area. Municipal wastes from Pacifica, Half Moon Bay, and the El Granada-Princeton area receive primary treatment and are discharged to the Pacific Ocean via outfall sewer. Montara has a community septic tank. In the San Gregorio Basin, 2 organizational camps and 1 oil company are under discharge permits by the San Francisco Bay Regional Water Quality Control Board, all discharging to land. Two parks and an organizational camp in the Pescadero Basin have discharge permits and dispose of secondary treated wastes by spray field disposal.

The recent experience of high nitrate concentrations in the Pescadero ground water aquifer, believed to be caused by septic tank leaching, is the only case known to the County Health Department where domestic or urban wastes have caused ground water pollution. Most aquifers have an overlying impervious strata which gives some protection from surface contamination.

Undoubtedly, there is some degradation of mineral quality in water used for agriculture. However, most irrigation occurs on the marine terrace, adjacent to the coast, and there is probably nagligible reuse of water prior to it reaching the ocean. No future problems are expected from agricultural water degradation since it appears likely that reuse will remain negligible.

Water Quality Criteria

No specific water quality goals have been established for the San Mateo County coastal streams by local, regional, or State agencies. However, the County has given considerable thought to municipal waste collection and disposal and their future intent is expressed in the County Master Plan. Preservation of a certain level of water quality is implicit in the objectives outlined in the County Master Plan.

Basically, the County requires all new subdivisions to be in a sewer district prior to approval. The sewer district must have plans to treat and dispose of sewage from the subdivision. The sewage discharge must meet requirements set by the Regional Water Quality Control Board. Individual home builders must have sewage disposal plans approved by the County prior to construction. In 1964, the County retained two consulting engineering firms to make a joint study and report on long range waste disposal plans for the entire county. The recommended plan for the

Coastside called for four separate sewage systems: (1) a combined system serving the North Coast area with ocean outfall sewer located north of Point San Pedro; (2) a combined system serving Half Moon Bay, Montara, Granada, Moss Beach, and Princeton, with ocean outfall located west of North Granada; (3) a treatment plant and ocean outfall serving the Lobitos-Tunitas area; and (4) a treatment plant and ocean outfall serving the Pescadero area. It was projected that the San Gregorio Basin and the remainder of the South Coastal area would remain sparsely populated and no sewage collection system would be needed. The report also concludes that after 1990 one of the alternative methods of disposal for Bay-Side San Mateo County is to pump effluent to the Coast with discharge via ocean outfall. It is the County's intent to follow the general recommendations of this report.

The San Francisco Bay Regional Water Quality Control Board has not yet set water quality standards for the coastal streams but their policy in other parts of their region is not to allow any discharge to small streams such as these. Water quality control boards have authority under state law to set receiving water or effluent standards on individual dischargers and to enforce these standards by legal means if necessary. The State Health Department has recommended that there be no direct discharge of sewage effluent to streams or reservoirs, and no detectable sewage in streams or reservoirs from runoff or leaching.

Flow Regulation

Waste disposal to the ocean is expected to continue in those areas where it is already established. Disposal to land is expected to continue in areas of scattered population. Discharge to streams might be considered in new residential areas that develop along a creek and are at least a mile from the ocean. Only Pescadero and San Gregorio Creek meet these requirements. Since water resource developments are possible on both streams consideration will be given in this section to stream discharge with provision of storage for water quality control.

Pertinent factors to consider in evaluating the desirability of waste discharges to Pescadero or San Gregorio Creeks are:

(1) There are significant fishery resources on Pescadero Creek and apparently a limited fishery on San Gregorio Creek. The increased flow caused by waste discharges, with flow augumentation as needed, would probably tend to enhance the fishery. But a municipal waste discharge even with flow augumentation would be expected to decrease the naturally high dissolved oxygen (DO) concentration from about 8 mg/l to 5-6 mg/l (depending on the criteria used) and this is considered a less desirable fish habitat. No figures are available on possible enhancement benefits from increased flow. Nor is there information on the willingness of the Fish and Wildlife Service and State Department of Fish and Game to accept more flow with a lower DO.

(2) Both streams flow across one of the San Mateo Beach State Parks as they discharge to the ocean. The State Health Department reports that the 1962 recreational use at the two parks was over 1 million visitor days. The beaches are used extensively for sports harvesting of clams, mussels, abalone, and sea snails; surf-fishing; marine biology studies; wading and swimming. In 1962 the State Health Department issued a certificate permitting the commercial harvesting of mussels for human consumption from Pescadero Beach - South. The flow of diluted effluent across these beaches would be a potential health problem. The knowledge that outflow contains sewage effluent would be esthetically objectionable to some recreators.

(3) There are reasonable alternate means of disposing of treated waste effluent. Discharge by ocean outfall is currently practiced in the area. Use for irrigation would be an economic benefit to agriculture which is presently limited by problems of water supply. Any savings in treatment and disposal costs resulting from discharging to streams would be marginal, even if costs of flow augmentation water is ignored. In fact, the cost could be greater because typical discharge regulations permit primary treated wastes to be discharged through an outfall and require discharges to streams to have secondary treatment. Wastes used for irrigation may require either primary or secondary treatment (depending on the crop being irrigated) and would provide some revenue to defray treatment and disposal costs.

(4) The value of water in alternate uses is high. The return to land and water of the specialty crops normally grown in this area have been estimated to range between $45 - 235/acre foot of applied water. Cost per acre foot of conservation yield are $20-40 per acre foot at the dam.

(5) The County Health Department, Regional Water Quality Control Board, and State Health Department have indicated their preference for keeping wastes out of these streams.

It is concluded that the disadvantages of discharging to streams in this area substantially outweigh the advantages. Therefore, no further consideration is given to provision of storage for water quality control in reservoirs constructed in the San Mateo Coastal area.

BENEFITS

Municipal Water Supply

The single purpose, least cost alternative approach was used to determine the value of providing a municipal water supply to the San Mateo Coastal Area. Additional developments were assumed to be staged as needed with costs discounted to 1975 using a 3 1/8% interest rate. To arrive at a value for conservation storage it was necessary to estimate both water supply development and water conveyance costs since the choice of development plan will effect water conveyance costs. It was also necessary to consider differences in treatment cost and water quality detriments between different plans. The evaluation was made separately for the North Coastal Area and for the Central-South Coastal Area. The procedures used, assumptions made, and tabulated costs are given in more detail in the appendix.

Quality Differences. There are significant differences in quality among the coastal streams and water from the San Francisco Water Department is of much better quality than any of them. The computed differences based on flow weighted hardness concentration were used to determine the economic detriments incurred in using waters of greater hardness concentration. The coefficient used was $0.022 per milligram per liter per acre foot of hardness differential.

Water Treatment Differences. In order to compare the costs of delivering treated San Francisco water to the North Coastal Area with costs of developing and delivering untreated coastal water it was necessary to include the cost of complete treatment (coagulation, sedimentation filtration and disinfection or equivalent) of the coastal supply. A difference in treatment costs was assigned to the two alternatives considered for the Central-South Coastal Areas because one alternate would require several small plants whose unit costs of treatment are higher.

North Coastal Area. Water supply from the San Francisco Water Department was considered as the least-cost, most likely alternate supply to this area. It was necessary to make allowances before comparing the treated San Francisco water with its high mineral quality with the untreated, lower mineral quality water from coastal streams. Also, since San Francisco water may be purchased as needed its unit cost cannot be compared directly with the unit cost of coastal water based on the cost per acre foot of yield available. For simplicity the benefits are given on an annual basis only.

The benefits from providing all of the water needs after 1980 have a present worth of $15,700,000 in 1975 or $513,000 per year. If only the increased water usage after 1980 is provided from coastal sources the 1975 present worth is $6,380,000 or $209,000 per year. These benefits should be compared to the incremental cost of extending the coastal water resource development plan (both conservation and conveyance features) to include service to this area (it being assumed that the Central-South Coastal Areas will be served by these developments).

Central and South Coastal Areas. Two alternate plans were evaluated. Alternate #1 was the plan found to be most economical by the DWR's investigation. Initially this plan involves offstream storage of diverted Pescadero and Butano Creek waters into Bean Hollow Reservoir on Arroyo de Los Frijoles Creek. Since the DWR's findings were based on different municipal water use figures, included some irrigation water, and assumed initial operation in 1970 a second alternate was considered. Alternate #2 assumed San Francisco would supply the supplemental needs of the Central Coastal Area until 1980 and that communities in the South Coastal Area could be served until 1980 by diversion from local streams and conveyance to reservoirs providing sufficient storage to meet the dry-season demand. In 1980 major conservation works, such as in Alternate #1 would be developed. Initial development of a single-purpose reservoir at Worley Flat with a pumped diversion near Pescadero was investigated but found to be more costly than either Alternate #1 or #2. The 1975 present worth was computed for each product with the total worth being broken down into conveyance and conservation costs, and treatment and quality detriments.

Alternate #2 was estimated to be 2% cheaper than Alternate #1 and is considered the least-cost alternate means of providing water supply to the Central and South Coastal Areas from 1975-2075. The present worth of this plan is $29.2 million (9.3 for conveyance, 19.7 for conservations works, 0.1 for quality and 0.1 for treatment). The total water supply benefit for a multiple purpose project is then $29.2 million. This is equal to a total of $76.0 per present equivalent acre foot of water used with the subtotals being $51.4 for conservation and $24.6 for conveyance.

The total water conservation benefit from water resource is determined by subtracting the present worth of the conveyance, quality, and treatment components applicable to the project from $29.2 million. For initial construction on Pescadero Creek the total conservation benefit is $19.5 million.

The conservation benefit from an initial project is obtained by determining the most economical water conservation developments following the first stage, determining their 1975 present worth, and subtracting this value from the total conservation benefit. For 10,000 acre foot yield on

Pescadero Creek the benefit would be $11.6 million or $380,000 per year. These benefits assumed water is delivered to the Pescadero site at an elevation equivalent to the average pool in Bean Hollow Reservoir (about 200 feet) so the costs of delivering the yield to that point must be considered as a part of the water conservation cost.

It should be noted that all of the Central and South Coastal area supplemental water needs for the 1975-2075 period could be purchased from San Francisco for $23.3 million (1975 present worth) or $833,000 per year if the price remains at $66 per acre foot delivered. The quality benefit would be $3.8 per acre foot or $1.46 million present worth. Differences in treatment costs would be $13.9 per acre foot or $5.33 million. Thus the conservation cost of receiving an equivalent supply from San Francisco would have a 1975 present worth of $18.5 million or $48.2 per acre foot. If conveyance costs remained about the same it would be cheaper (by $1.2 million present worth or about $40,000/year) to purchase San Francisco water for the entire 1975-2075 period.

Water Quality Control

Wastes from the study area are handled by ocean discharge or land application. It is expected that these methods of waste disposal will continue to be used. There is therefore no need to regulate streamflow to maintain water quality and no benefits to be obtained by provision of storage for water quality control purposes in connection with water resources development in the San Mateo Coastal Area.

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APPENDIX A

MUNICIPAL AND INDUSTRIAL WATER SUPPLY BENEFITS

The value of an M & I water supply is generally considered to be equal to the cost of an alternate single-purpose project likely to be used in the absence of the project which will yield the same amount of water of equal quality delivered to the same point of need provided this alternate cost is considered reasonable. This costs must include the difference in transportation costs and in treatment costs if the quality of water from the alternative is inferior to water from the proposed project. Total and annual costs are given with the annual costs also including Operation and Maintenance expense. The annual cost must be discounted from the time of first need to a stated date, unless the need is immediate. Furthermore, the value should be expressed as the value at the proposed Federal reservoir, not the value delivered to the communities.

This criteria is not easily applied to the San Mateo Coastal Area for the following reasons:

1. The present population is sparse and widely scattered.

2. The rate and specific location of population growth cannot be forecast with certainty.

3. The area consist of numerous watersheds from which small quantities of water could be developed. The unit cost of development of these watersheds is high although the costs of transmission are low since the sources are generally close to localized areas of need.

4. The area expected to have the greatest and earliest need for water (Central Coastal Area) is farthest from the most likely water resource developments and could most easily be served by the San Francisco Water Department. However, it is unlikely San Francisco will serve any water to this area after 1980 and the amount that would be supplied between 1968 and 1980 is uncertain.

5. Transmission costs are a substantial part of total water costs and vary with alternate projects.

6. Water quality from the several possible sources is quite variable. The quality is satisfactory in all cases but waters of different quality do have different values to M & I users and must be evaluated.

7. Only limited data is available as to the quantity and timing of runoff on some creeks that might be developed.

8. The extent to which riparian and appropriative water rights will influence the quantity of water available on some creeks is uncertain.

9. The time and magnitude of releases that may be required for fishery purposes is uncertain.

Quality Differences

The alternate plans provide water from different sources and of different quality. Differences in mineral quality of water used for municipal and industrial purposes do have an economic impact on the users that can be evaluated. Total hardness is the water quality parameter of primary economic importance to urban water users since increased hardness causes increased use of soap and scale formation in hot water heaters, dishwashers, pipes, and cooking utensils. Differences in total hardness are used to evaluate the cost of differences in water quality.

The flow-weighted total hardness was determined for each stream where quality data are available and is shown in Table 4 . Then for a particular development plan the yield-weighted hardness was determined for each stage of water conservation development by assuming that water from each development would be used in the proportion of its yield to the total developed yield. The present equivalent water use during each stage of water conservation development was determined by standard discounting methods. The product of the yield-weighted hardness and the present equivalent water use for each stage was then discounted to 1975. The sum of these products (discounted to 1975) divided by the present equivalent water use for the study period (discounted to 1975) gives the equivalent water quality for the alternative plan.

The cost of water softening is generally somewhat less than the damages resulting from hardness. Consequently, the cost of softening a harder water to that of a softer water can be considered as the benefit of using the softer water supply (or conversely, the difference measures the detriment incurred if the harder water supply is used). The Stanford Research Institute, in a study of water quality in the Upper Santa Ana Valley and coastal San Diego County, determined that the cost of softening Colorado River water to equal Northern California water was $0.022 per mg/l of hardness per acre foot removed. This figure is used to determine the benefits or detriments resulting from water quality differences.

Water Treatment Differences

It is assumed that all surface water developed for municipal use on the San Mateo Coast will require complete treatment (i.e. coagulation, sedimentation, filtration and disinfection or equivalent). San Francisco's

water supply is well protected and present treatment is limited to long-term storage, disinfection, and fluoridation. There are plans to begin complete treatment of water stored in San Francisco's San Mateo County terminal reservoirs within a few years but that portion of the supply coming from the Tuolumne River will not receive additional treatment. It is assumed here that all San Francisco water supplied to the North Coastal Area will not require additional treatment. The San Francisco water presently sold to Coastside County Water District from Pilarcitos Creek is not treated so it is assumed any water sold to this area between 1975 and 1980 will not be treated.

In comparing the equivalent cost of untreated coastal water with treated San Francisco Water it was necessary to substract the estimated cost of treating the coastal water. The cost of treatment can be divided into three categories: (1) capital costs of plant construction; (2) annual operation, maintenance, and repair costs (O,M,&R) and (3) cost of chemicals used in water treatment. The first two of these are related to size of plant. Construction costs can be approximated by the empirical relationship of:

$$\log \text{cost} = 5.44 + 0.66 \log (\text{MGD Capacity})$$

The economic life of treatment plants are assumed to be 40 years. Annual O,M,&R costs are assumed to be 3% of capital costs. The costs of chemicals is assumed to be $17.50 per million gallons treated ($5.70/AF).

It was arbitrarily assumed that alternate #1 would have $2,000 per year lower treatment costs than alternate #2 due to the possibilities of treating all water in one location and reducing unit costs. This savings would probably be $3-4 per acre foot of water treated in a large plant rather than the small units that would be needed at the pre 1980 developments. Since small units (such as diatomite filters) typically have low capital and high operating costs their use after 1980 would probably be only for emergencies or in years preceeding development of an incremental supply when their yield is needed.

NORTH COASTAL AREA

San Francisco Water Department will serve all needs of this area until 1980 when the present contract expires. This contract obligates the Water Department to continue to serve this area at the 1980 rate of usage perpetually. A new contract would have to be negotiated for San Francisco to supply the increased water usage after 1980. The North Coast County Water District is considering the possibility of obtaining all or a portion of their post 1980 needs from developments on the San Mateo Coast.

The only practical alternative to receiving water from the San Mateo Coast is to continue to receive it from San Francisco. The value of a coastal water supply can then be determined by estimating the cost of receiving water from San Francisco, Present cost of this water to municipalities is about $66 per acre foot of water actually used for users of more than 4,500 acre feet annually (1980 North Coast usage estimated at 7,100 acre feet). This water is treated (disinfected and fluoridated) and ready to use. It is also water of superior mineral quality, being somewhat lower in hardness and total dissolved solids than any of the streams on the San Mateo Coast. No information is available on possible changes in price in 1980 or whether it is more likely to increase or decrease. However, it is perhaps more likely that the price will decrease in the near future since much of the transmission system is inplace and the next increment of conservation yield (resulting from purchasing storage in New Don Pedro Reservoir on the Tuolumne River projected to cost about $10/AF of yield at the dam. It is assumed that the cost of treated water after 1980 will remain at $66 per acre foot of water actually used.

For a coastal water supply to be competitive with the San Francisco Water Department it must be delivered to the North Coastal Area and treated for $66 per acre foot less a "quality detriment" due to a much higher hardness concentration. Furthermore, since San Francisco's rates are per acre foot delivered the coastal supply must be figured on the same amount not on the yield available.

Table A-1 shows the projected benefits from providing untreated coastal water to the North Coastal Area for the period 1980-2075. The capitalized benefits determine the maximum incremental costs of economically serving the North Coastal Area from coastal sources for the entire period. A cursory evaluation indicates that it will be necessary to extensively develop San Gregorio Creek as well as Pescadero Creek if the North Coastal Area is also served and that it will be difficult to provide water at the equivalent cost of San Francisco's supply.

Alternate Supplies

Alternate #1 is explained in detail in the California State Department of Water Resources Bulletin No. 138 and is shown on Figure 2. It involves staged construction of water conservation works primarily in the Pescadero - Butano - Gazos Creek basins and separate conduits to serve the Central Coast, Pescadero, and Ano Nuevo areas. The initial unit is a pumped diversion from Pescadero Creek to Bean Hollow Reservoir on Arroya de los Frijoles Creek. Subsequently there is a diversion from Butano Creek, an increased Pescadero Creek diversion, an enlarged Bean Hollow Reservoir, and construction of Gazos Reservoir. Costs and dates of construction are shown in Table A-2. This alternate is assumed to become operational in 1975.

This is the plan the DWR found to be the most economical water supply development for the Central and South Coastal Area. However, it assumed initial operation in 1970, used different municipal water use projections, and included some irrigation water development. It is basically a single-purpose project to supply M&I and agricultural water although in their investigation the DWR considered recreation and fish and wildlife possibilities. The plan has the advantage of less interruption of other functions such as fishery or urban development. Conversely, the plan is less adaptable to multiple purpose aspects such as flood control, recreation development, and fishery enhancement.

Since this evaluation was made with different water use, years of initial operation, and evaluation period another alternate was also investigated. Alternate #2 was based on the indication that the San Francisco Water Department would consider serving the Half Moon Bay area until 1980 provided there was assurance local supplies would be available at that time. This plan would consist of maximum usage of San Francisco's Pilarcitos system with augumentation from Crystal Springs Reservoir when needed. Between 1975 and 1980 other areas would be served by locally developed streams diversions and terminal storage as follows: (1) Ano Nuevo area by Gazos (or Whitehouse) Creek diversion; (2) Pescadero area by Pescadero Creek diversion; (3) San Gregorio area by San Gregorio Creek diversion; (4) Pompanio area by Pompanio Creek diversion; and (5) Tunitas area by Tunitas (or Lobitos or Purisima) Creek diversion. In 1980 the San Francisco supply would be eliminated completely and replaced by alternate #1 works staged as needed. The local supplies could still be used to develop their yield (conservatively estimated at 2,800 acre feet per year). Costs and construction dates for this resource development scheme are shown in Table A-3.

This plan has the advantage of delaying construction of major conservation works and conduits for five years as well as development of

a small quantity of relatively cheap water that can be used continuously. Also the terminal storage necessary to insure a supply during the low flow months would be of advantage to distribution systems in future years although their entire costs has been charged to water development. It also allows construction to be adjusted to the extent of urban development. Furthermore, it is likely that some of these areas will need to develop stream sources prior to 1975 so that a portion of these costs would be incurred even if major development works were not delayed past 1975.

A disadvantage of the plan would be that a somewhat faster increase in water demand in an area would involve additional storage and possibly conveyance works and might exceed the capability of the interim plan to supply the demand. However, these per capita water use figures are somewhat higher than presently exist in the area and do not allow for usage from existing wells. Thus it is more likely that the demand will be less (and cheaper) than predicted. Another uncertainity is that flows on most of these streams have been determined by assuming the same runoff per square mile as at the Pescadero Creek gage so there is some doubt concerning the actual flows on these creeks. Also, the extent of riparian and appropriative water use is not certain, but this is true of all creeks including Pescadero. However, the assumptions made are believed to be conservative since dry weather flows in some streams may be greater than the Pescadero gage indicates (Purisima Creek records show a somewhat greater percent of the annual flow occuring during the dry season) and storage requirements were assumed to be 40% of the annual demand (enough for perhaps 3 1/2 months of summertime usage). It might be argued that the existence of an inplace conduit with excess water would be a decisive factor in increasing urban growth during the 1975-80 period but this is conjecture and not easily evaluated economically. It is likely that the existence of an area-wide water development agency that has demonstrated its capability and intent to provide water when needed would be an adequate incentive to development.

Procedure Used In Costing Alternates

1. All capital and Operation Maintenance, & Replacement (OM&R) costs used by Department of Water Resources in Bulletin No. 138 are used for those dams, diversion works, and conveyance units that are also used in alternates #1 or #2.

2. Dates of construction are staged as necessary to meet the Supplemental Water Needs projected in Table 9 . There is one exception: it is assumed that one half of the water needs in the San Gregorio Basin are in the La Honda area and are not served by the project. This is: (1) because the area is projected to remain isolated from the coastal urban development and is at a somewhat higher elevation than other service areas; (2) the costs of supplying it by alternate #1 or #2 would be similar (although they would be different from Worley Flat); and (3) it appears likely that development of upper San Gregorio Creek and tributaries would be less expensive.

3. Gravity diversion works in alternate #2 are assumed to cost $10,000. Costs of conveyance units from diversion point to the local distribution system are assumed the same per foot as in Bulletin No. 138. Costs of terminal storage reservoirs (concrete lined open cut reservoir) varies from $55,000 for 1 million gallons to $300,000 for 20 million gallons. OM&R costs are assumed to be $300/year for diversions and vary from $800 - $2,000/year for reservoirs.

4. Cost of San Francisco water is taken as $66 per acre foot plus $9/AF pumping (although much of the water would not have to be pumped) and $250,000 conveyance and pump costs from Crystal Springs Reservoir. It is possible the pumped facility from Crystal Springs would be needed prior to 1975, but it is assumed to be due only to delay of the project from 1975-1980.

5. Costs were determined by using a 3 1/8% interest rate in discounting to 1975. Salvage value of works at the end of the evaluation period were ignored and the Operation, Maintenance, and Replacement costs used by DWR are assumed to allow for replacement of units whose economic life is less than the evaluation period.

Determination of Benefits

Since the study period is 100 years, 1975-2075, the formulation of a water resource development plan should seek to minimize the economic costs of meeting the projected needs during this period. The evaluation, then, should not be limited to determining the most economical initial development but should also consider the effect it has on succeeding developments. The values developed here will be combined into a 1975 present worth. If developments are built in a different sequence the effect of this deviation on future projects should be compared with the alternatives.

The evaluation does not consider financial aspects since differences in borrowing rates and repayment period between local and federal financing have no bearing on the national efficiency benefits being evaluated in Federal Water Resource projects. For this reason, single purpose alternative costs are computed at the federal rate (3 1/8%). A computation was made at the 4% interest rate to determine sensitivity to interest rates and its possible effect on the local choice of alternatives. The two alternates were not sensitive to this change in interest rates.

Adjustments were then made in the capitalized cost for quality and treatment benefits or detriments. The conservation and conveyance capitalized costs were then separated. Table A-4 shows this separation for Alternates #1 and #2. Also shown is the determination of conservation benefits that would result from building the initial development at Worley Flats on Pescadero Creek. Note that the least total cost is determined by Alternate #2 but that the conveyance costs for the Worley development are greater

than for Alternate #2. Thus, the conservation benefits are less that for Alternate #2. Also, the conservation cost must include the means of delivering water conse... at Worley Flat to the Pescadero diversion site and lifting it to an elevation equivalent to the average pool elevation at Bean Hollow Reservoir.

To get the water supply benefits attributable to an initial development on Worley Flat it is necessary to assume a yield for the project and then determine the capitalized cost of the subsequent conservation works that will be needed. For example, if a 10,000 acre foot safe conservation yield is developed at Worley the subsequent single-purpose projects might include: the stream diversions of Alternate #2 in 1994; a Butano diversion and Bean Hollow Reservoir in 2001; a Pescadero diversion in 2014; an enlarged Bean Hollow Reservoir in 2025 and Gazos #1 Reservoir in 2049. The cost of these projects capitalized to 1975 would be $7,840,000 and the benefit from the Worley Reservoir system would be $11,610,000 (or $380,000/year).

Costs or benefits are sometimes expressed in dollars per acre foot. This gives an indication of the relative cost of water since the price can be compared to other projects. Unit costs can be expressed either in dollars per acre foot of yield or dollars per acre foot of water used. The later is more precise because it reflects the burden that unused capacity inflicts upon the water user. For instance, a reservoir with 10,000 acre feet yield and costing $100,000/year is not cheaper to the user than one with 5,000 acre feet yield for $80,000/year if only 4,000 acre feet per year is needed. In this study area it would be incorrect to compare San Francisco water which can be purchased only if needed (at a relatively expensive rate) with the unit cost of unused yield in a coastal reservoir.

The projected water use during the study period can be discounted to 1975 and a present equivalent value determined. The projected present equivalent water used for the study period is 384,000 acre feet or 12,600 acre feet per year. For alternate #2 this gives a total cost of $76.0/acre foot ($51.4 for conservation and $24.6 for conveyance).

DISCUSSION

Alternates #1 and #2 have essentially equal costs, but this could change under a feasibility grade evaluation. These alternates do not, by any means, exhaust the possibilities of economically developing coastal water resources since the topography and hydrology of this area with its numerous streams offers a large number of possible solutions. Further consideration could be given to ground water development to supply a portion of the needs. Also, the possibilities of using a portion of the surplus agricultural water projected to exist in the future should not be overlooked. However, these values are believed to be close enough to the absolute least - cost, single purpose alternative to be used as a basis for determination of water supply benefits from multiple-purpose projects.

The actual costs and benefits computed here are only as good as the data used for the computation. The population and water use projections represent best estimates of future conditions and though time may prove them in error it is difficult to see how their reliability can be increased by reevaluation during the next few years (when more detailed analyses of this project are being made).

However, it is likely that more refined hydrology as well as detailed, updated construction cost estimates will be developed. There may also be more definite information on the San Francisco Water Department's plans. These more accurate numbers can be used in adjusting least costs and water supply benefits provided this is done in a consistent manner and applied to both alternates and recommended projects. However, this methodology should still be used.

TABLE A-1

WATER SUPPLY BENEFITS
FROM SUPPLYING 1/
NORTH COASTAL AREA FROM COASTAL SOURCES

	If Supply All Water in Excess of 7,100 AF/Y ($/AF)	If Supply All Water ($/AF)
Cost of San Francisco Water	66	66
Less Quality Detriment 2/	- 4.75	- 4.22
Less Treatment Costs 3/	- 16.5	- 13.9
Equivalent Cost S. F. Water	44.75	47.88
Say	44.8	47.9
Equivalent Acre Ft/Year Supplied (1980-2075)	5,480	12,600
1975 Present Worth	$6,380,000	$15,700,000
Annual Benefits (1975-2075)	$209,000	$513,000

1/ Based on purchase of treated water from San Francisco Water Department at $66/acre foot as most likely alternate supply. Benefits are for water delivered at the boundary of North Coastal Area.

2/ Quality Detriment = $0.022 /ppm Coast Hardness - ppm S. F. Hardness/ with S. F. Hardness = 35, Coast hardness = 251 when supplying needs over 7,100 AF and 227 when supplying all needs.

3/ Treatment Cost. Capital cost of $800,000 for 5 MGD plant and $1,400,000 for 12 MGD plant, maintenance 3% capital costs, and 17.50/MG treated for chemicals.

TABLE A-2

CENTRAL AND SOUTH COASTAL AREAS
COSTS OF ALTERNATE #1
(DEPARTMENT OF WATER RESOURCES PLAN)

Year	Development	Capital Cost When Built (10^6)	Capital Cost 1975 (10^6)	O&M Cost Annual (10^6)	O&M Cost Capit. 1975 (10^6)	Cumulative Yield (10^3 AF/Y)
1975	Bean Hollow and Pescadero Diversion	-	6.12	.122	3.72	7.0
1985	Butano Diversion	1.10	0.81	.055	1.21	10.0
1993	Enlarge Bean Hollow Reservoir and Pescadero Diversion Gazos #1 Reservoir	4.72	2.71	.085	1.44	19.6
2021	Enl. Pescadero Diversion	11.82	2.87	.116	0.73	27.5
2063	Denniston Reservoir	2.58	0.17	.055	0.04	28.8
			12.68		7.14	
Conduits - Bean Hollow to:						
1975	Half Moon Bay (8,000)	-	2.86	0.0768	2.35	
	Ano-Nuevo (1,600)	-	0.47	0.0116	0.28	
	Pescadero (2,000)	-	0.14	0.0055	0.14	
1993	Half Moon Bay #2 (16,000)	4.48	2.58	0.121	0.95	
2032	Ano-Nuevo #2 (1,600)	0.47	0.08	0.0116	0.05	
2034	Pescadero #2 (2,000)	0.14	0.02	0.0055	0.02	
			6.15		3.79	
	TOTALS		18.83		10.93	

1975 Present Worth = $29,760,000
Annual Cost = $ 976,000

TABLE A-3

CENTRAL AND SOUTH COASTAL AREAS
COSTS OF ALTERNATE #2
(Assumes San Francisco Water Available to Central Coast Until 1980)

Year	Development	10^6 Capital Costs When Built	10^6 Capital Costs 1975	10^6 OM&R Costs Annual	10^6 OM&R Costs Capitalized-1975	Cumulative Yield	
1975-1980	Ano Nuevo System	-	0.52	.0091	0.28		
	Pescadero System	-	0.52	.0092	0.28		
	San Gregorio System	-	0.27	.0038	0.12		
	Pomponio System	-	0.20	.0045	0.14		
	Tunitas System	-	0.29	.0032	0.10	2,800	
	San Francisco Water	-	1.34		-		
Sub-Total	Pre 1980 Works		3.14		0.92		
1980	Bean Hollow Reservoir & Pescadero Diversion	6.12	5.25	0.122	3.15	9,800	
	Conduits from Bean Hollow to Half Moon Bay, Pescadero, Ano Nuevo	4.79	4.10	0.138	3.58		*
1993	Butano Diversion	1.10	0.63	0.055	0.93	12,800	
2001	Enlarged Bean Hollow Res. & Pescadero Diversion	4.72	2.12	0.085	1.10	22,400	
2015	Conduit-Bean Hollow to Half Moon Bay	2.86	0.84	0.077	0.60		*
2032	Conduit-Bean Hollow to Ano Nuevo	0.47	0.08	0.012	0.05		*
2033	Gazos #1 & Enlarged Pescadero Diversion	11.82	1.99	0.116	0.50	30,300	
2034	Conduit-Bean Hollow to Pescadero	0.14	0.02	0.126	0.02		
Sub-Total	Post 1980 Works		15.03		9.93		
Total			18.17		10.85 = $29.02 x 10^6$		
					= $953,000/Year		

*Conveyance Cost. Others are Conservation Costs.

TABLE A-4

PRESENT WORTH (1975) OF
ALTERNATE PROJECTS TO SUPPLY
CENTRAL AND SOUTH COASTAL AREAS
(1975 - 2075)

ALTERNATE COSTS (MILLION DOLLARS)

	#1 Alternate (DWR)	#2 Alternate (1980)	Multi-Purpose Worley First 2/
Total	29.76	29.02	(29.08)
Conveyance	9.94	9.29	9.63
Conservation	19.82	19.73	(19.45)
Treatment Detriment	0	0.06	0
Quality Detriment 1/	0	0.10	0.10
Total, Adjusted	29.76	29.18	29.18

1/ Flow Weighted Hardness Computed to be 197 for #1, 209 for #2, 208 for Worley First.

2/ Worley Conveyance Costs Vary From Alternate #1 for Equivalent Service. Cost of Diversion at Pescadero Site and Pumping to Elevation of Bean Hollow are Conservation Costs. The Values in Parenthesis are Computed by Difference After Least-Cost of Alternate and Fixed Costs of Conduit and Quality Detriment Were Established.

3/ Hardness Determined by Assuming Following Post Worley Developments. 1994-Pre 1980 stream diversions, 2001 - Bean Hollow and Butano Diversions, 2014 - Pescadero Diversion, 2025 - Enlarged Bean Hollow, 2049 - Gazos #1.

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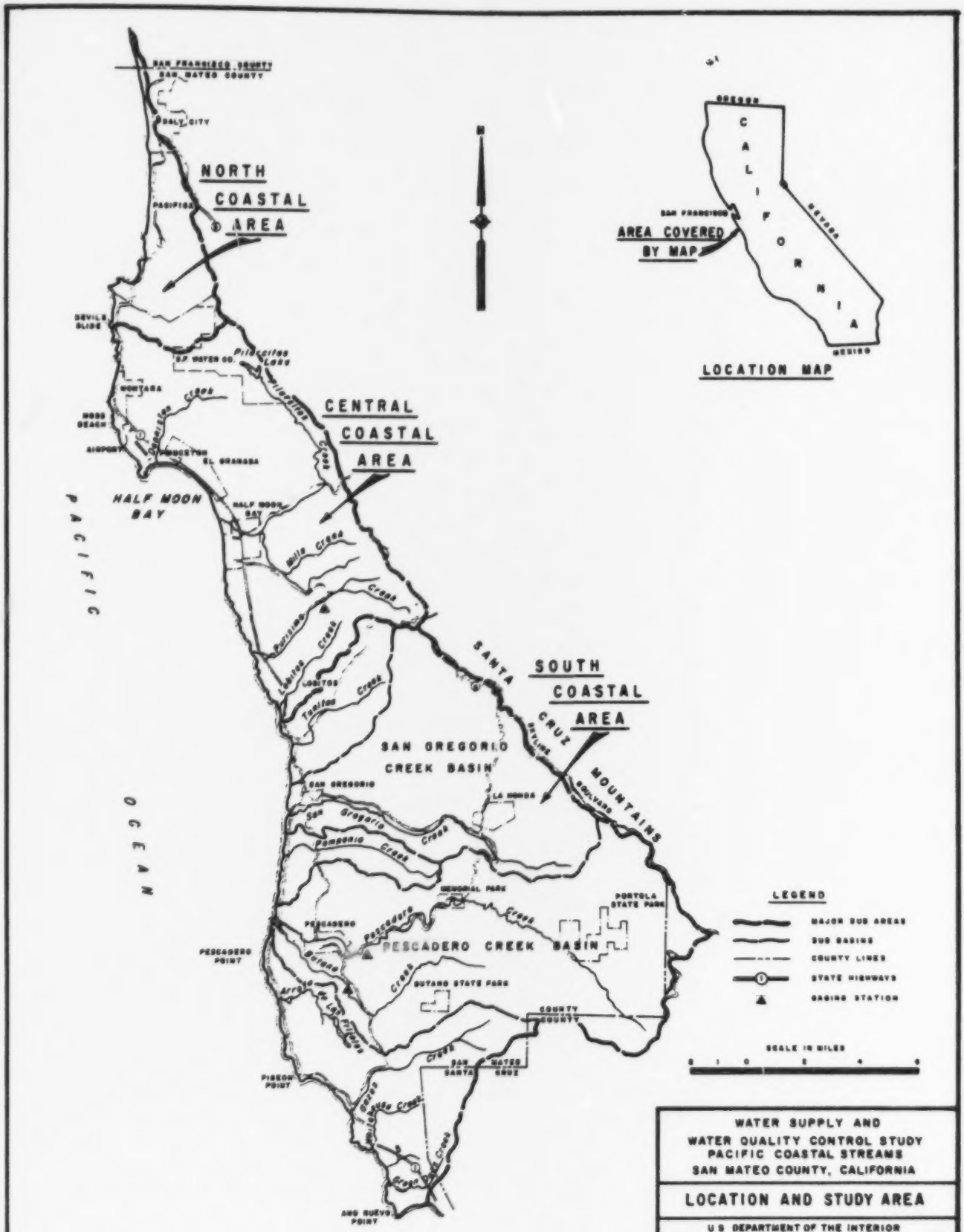
NORTH COASTAL AREA
CENTRAL COASTAL AREA
SOUTH COASTAL AREA
SAN GREGORIO CREEK BASIN
PESCADERO CREEK BASIN
HALF MOON BAY
PACIFIC OCEAN
SANTA CRUZ MOUNTAINS
AREA COVERED BY MAP
CALIFORNIA
LOCATION MAP
LEGEND
MAJOR SUB AREAS
SUB BASINS
COUNTY LINES
STATE HIGHWAYS
GAGING STATION
SCALE IN MILES
WATER SUPPLY AND
WATER QUALITY CONTROL STUDY
PACIFIC COASTAL STREAMS
SAN MATEO COUNTY, CALIFORNIA
LOCATION AND STUDY AREA
U S DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
SAN FRANCISCO, CALIFORNIA

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FIGURE 1

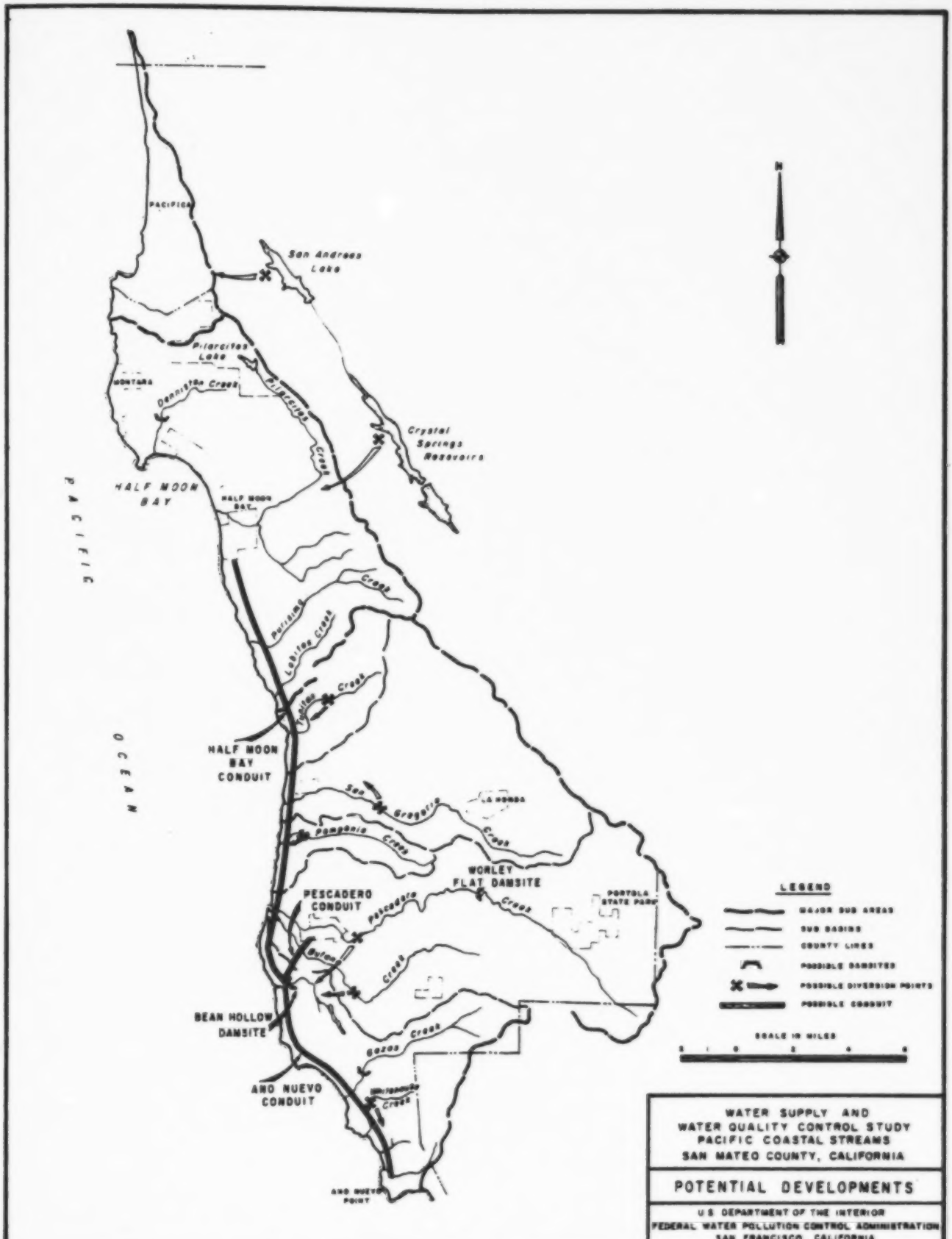
N
PACIFIC
San Andreas Lake
Pilarcitos Lake
MONTARA
Denniston Creek
Pilarcitos Creek
Crystal Springs Reservoirs
HALF MOON BAY
HALF MOON BAY
PACIFIC
OCEAN
Denniston Creek
Pilarcitos Creek
Lobitos Creek
Lobitos Creek
HALF MOON BAY CONDUIT
San Gregorio Creek
LA HONDA
Pomponio Creek
Pomponio Creek
WORLEY FLAT DAMSITE
PESCADERO CONDUIT
Pescadero Creek
PORTOLA STATE PARK
Butano Creek
Butano Creek
BEAN HOLLOW DAMSITE
Gazos Creek
AÑO NUEVO CONDUIT
Gazos Creek
AÑO NUEVO POINT
LEGEND
MAJOR SUB AREAS
SUB BASINS
COUNTY LINES
POSSIBLE RESERVOIRS
POSSIBLE DIVERSION POINTS
POSSIBLE CONDUIT
SCALE IN MILES
5 4 3 2 1 0
WATER SUPPLY AND
WATER QUALITY CONTROL STUDY
PACIFIC COASTAL STREAMS
SAN MATEO COUNTY, CALIFORNIA
POTENTIAL DEVELOPMENTS
U.S. DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
SAN FRANCISCO, CALIFORNIA

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FIGURE 2